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JUL 2 8 1997

CALFED Bay-Delta Program Office
1416 Ninth Street, Suite 1155
Sacramento CA 95814

Research Proposal Entitled
"Biological Evaluation of the Effectiveness of Screens for Fish Protection at Agricultural Diversions"
RFP: 1997 Category III Ecosystem Restoration Projects and Programs
Principal Investigator - J.J. Cech

Dear Colleague:

It is our pleasure to present for your consideration the referenced proposal in response to **the CALFED Bay-Delta Program RFP.**

Please call on the principal investigator for scientific information. Administrative questions may be directed to me or my assistant, René Domino, at the above address and phone number. We request that correspondence pertaining to this proposal and a subsequent award be sent to the Office of Research and to the principal investigator.

Sincerely,

Sandra M. Dowdy
Contracts and Grants Analyst

Enclosure

cc: J.J. Cech

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I. EXECUTIVE SUMMARY

A. Project Title and Applicant Name

BIOLOGICAL EVALUATION OF THE EFFECTIVENESS OF SCREENS FOR FISH PROTECTION AT AGRICULTURAL DIVERSIONS; Dr. Joseph J. Cech, Jr. UC Davis

B. Project Description and Primary Biological/Ecological Objectives

The objectives of this project are to evaluate the effectiveness of small diversion fish screens for fish exclusion and fish protection. This project addresses a major environmental stressor identified by CALFED, alteration of flows and effects of water management activities, and will evaluate the effectiveness of one of CALFED's primary mitigation strategies, installation of fish screens, for fish protection. Specific questions addressed include:

Do fish screens exclude fish?

Are excluded fish harmed or killed by exposure and possible contact with the screen?

Do these responses differ among species, environmental conditions, or screen types?

Answers to these questions will assist environmental managers and water users to make decisions regarding screening of these types of diversions and apply adaptive management techniques in water diversions operation which protect fish and enhance ecosystem quality.

C. Approach/Tasks/Schedule

The approach of this project is to quantitatively evaluate the physiological and behavioral responses of several small-size priority fish species (chinook salmon, delta smelt, splittail, and steelhead trout) exposed to unscreened and several types of screened diversions under controlled environmental conditions in a large, laboratory-based flume (Agricultural Diversion Apparatus, ADA). At the experimental 12-inch pipe diversion (5-8 cfs) installed in the flume, four screen treatments (unscreened, 6-9 fps approach velocity; and three commercially available fish screens with regulation mesh size and operated at 0.33 fps approach velocity) will be tested with two different lateral flow velocities (0 and 0.5 fps), two seasonal temperature regimes (12 and 19°C), and during the day and night. Measurements will include fish behavior (e.g., swimming velocity, distance from screen surface), impingements, stress (e.g., plasma cortisol concentrations), and mortality.

The 2.5 year project is scheduled in two phases. Phase 1 (6 months) will include final design, construction, and testing of the ADA and preparation of a Quality Assurance Project Plan. Biological tests will be conducted during Phase 2 (2 years). The unscreened and fixed cylindrical fish screen treatments will be tested during the first year of Phase 2 in order to provide complementary data for a proposed IEP field project monitoring the effectiveness of these screen types for fish exclusion at Sherman Island in the Delta. A rotating cylindrical screen and a conical screen will be tested during the second year of Phase 2.

D. Justification for Project and Funding by CALFED

Installation of fish screens at unscreened water diversions has been identified by CALFED as an activity which provides direct benefit to fish resources and the ecosystem. However, except for some limited evidence that fish screens exclude fishes >5 mm in length, there is no information on whether excluded fishes are harmed or killed by exposure to artificial flow regimes and/or impingement on the screen. Therefore, the effectiveness of fish screens for fish protection is unknown and unproven. The proposed project will evaluate the effectiveness of small diversion fish screens for both fish exclusion and fish protection, with an emphasis on small-size, priority species

which may be at greater risk from these installations.

This project should be funded under the CALFED program for several reasons. It addresses questions and will produce information applicable to mitigate problems in the Sacramento-San Joaquin Delta and river system associated with alteration of flows and effects of water management activities, a key stressor identified by CALFED. It focuses on priority species that are documented to be at risk from the stressor. Understanding of the effects of installation of fish screens, beyond the issue of fish exclusion to that of fish protection, is essential to the CALFED mission of ecosystem restoration, enhancing fish populations (including fish doubling goals mandated by the CVIPA), providing information and tools for adaptive management by agencies and water users, and maintaining water use by small diverters throughout the system.

E. Budget Costs and Third Party Impacts

Total funding requested from CALFED is $622,940 for 2.5 years. This amount includes funds for equipment, supplies, and labor for construction of the ADA, salaries and benefits of personnel (post-graduate research biologists and hydraulic engineers), travel, publication costs, and overhead. Additional support will be provided by our funding partners, including UC Davis, DWR, DFG, and several fish screen and pump manufacturers. Potential third party impacts resulting this project include enhanced sport, commercial, and native Californian fisheries resulting from improved fish populations, and the improved ability of small water users to operate diversions in ways which better protect Delta and riverine fishes.

F. Applicant Qualifications

Dr. Joseph J. Cech, Jr., is a professor at the University of California, Davis, and a well recognized authority on physiology and behavior of fishes. He has successfully completed seven state agency contracts, many with an emphasis on Delta and riverine fishes. He is currently co-principal investigator, with Dr. M. L. Kavvas, a hydraulic engineer and collaborating scientist for this project, on a study of the performance and behavior of Delta fishes exposed to large flat plate fish screens.

G. Monitoring and Data Evaluation

Data collection and evaluation will be thoroughly described in a Quality Assurance Project Plan prepared by the principal investigator and research staff and reviewed and approved by experts from collaborating agencies. In addition to quarterly, annual and final reports, results will be presented at interagency workgroup meetings, workshops, and professional scientific meetings, and published in peer-reviewed journals.

H. Local Support/Coordination with Other Programs/Compatibility with CALFED Objectives

Most of the infrastructure and capitol equipment required for this project is already available at the UCD Hydraulics Laboratory, UCD Aquatic Center, and UCD Fish Environmental Biology Laboratory. Extensive cooperative and collaborative research and funding arrangements between the applicant, other UCD researchers, state agencies (e.g., DWR, DFG), and several fish screen and pump manufacturers are in place or pending. This project complements several ongoing and proposed projects investigating fish responses to fish screens, and fish screen effectiveness and hydraulic performance.

II. TITLE PAGE

Title of project: **BIOLOGICAL EVALUATION OF THE EFFECTIVENESS OF SCREENS FOR FISH PROTECTION AT AGRICULTURAL DIVERSIONS**

Principle Investigator: Joseph J. Cech, Jr., Professor
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Type of Organization and Tax Status: State assisted public research and educational institution

Tax Identification Number: 94-603-6494

Technical and Financial Contact Persons:

Technical: Joseph J. Cech, Jr., Professor
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Participants and Collaborators in Implementation:

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California Department of Fish and Game
California Department of Water Resources
Claude Laval Corp.
U. S. Filter/Johnson Screens (pending)
Cornell Pump Co. (pending)

RFP Project Group Type: Construction (planning study); Monitoring, Assessment and Reporting

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III. PROJECT DESCRIPTION

A. Project Description and Approach

1. Introduction

Water diversions in the Sacramento-San Joaquin Delta and river system have serious deleterious effects on many resident and transient fishes. Most management concerns and research efforts have focused on large diversions (e.g., state and federal pumping facilities, and industrial and urban water diversions). However, the majority of the water diversions located throughout the system are small (<50 cfs), unscreened agricultural diversions that, combined, divert as much water as that exported by the state and federal pumping facilities in the south Delta. Fish entrainment losses have been quantified at a limited number of agricultural diversions in the Delta and there is some evidence that installation of fish screens effectively excludes fishes larger than 5 mm total length (IEP, Technical Report 37, 1994). However, there is no information on whether larger fishes are entrained and impinged at these screened diversions and whether such exposure is harmful. Does exclusion protect fish? Can entrained fish escape or do they impinge on the fish screen? Is impingement stressful or lethal? Do the effects of entrainment and impingement differ among species, screen types, or with environmental conditions? For Delta fishes these questions have not been answered. Therefore, the effectiveness of past and present screening efforts throughout the system, including those implemented under the CALFED program, for protecting these aquatic resources and improving ecosystem quality is unknown.

We propose to evaluate the effects of exposure to screened and unscreened agricultural-type diversions on several priority Delta fish species using a laboratory-based agricultural diversion apparatus. This will be the first biological evaluation of the effectiveness of fish screens for Delta fish protection rather than simply fish exclusion. Our results will assist environmental and resource managers to make decisions regarding screening of agricultural-type diversions in ways which truly protect fish, enhance ecosystem quality, and contribute to fish doubling goals mandated by the CVPIA. In addition, this project complements at least two other proposed projects to evaluate small diversion fish screens, an IEP field research and monitoring project to evaluate the effectiveness of a fish screen at an agricultural diversion in the Delta (Sherman Island) and a USBR project to quantitatively describe and evaluate the hydraulic performance of a selection of commercially available small diversion fish screens.

2. Objective

The objective of the project is to evaluate and quantify the behavioral and physiological responses of selected Delta fishes exposed to unscreened and several types of screened agricultural water diversions under selected environmental conditions.

3. Methods

Experiments will be conducted using a large scale, laboratory-based flume equipped with a pipe diversion which can be fitted with several different screen types. The apparatus is designed to provide controlled flow and environmental conditions, and fish screen installations similar to those used at some agricultural diversions in the Delta. This approach will enable us to test fishes in clear water conditions, to quantitatively observe and track their movements and responses to the diversion and screen, and to assess any lethal and sublethal effects of exposure and impingement. Specific aspects of the experimental design and ranges of variables are outlined below.

Agricultural Diversion Apparatus: The agricultural diversion apparatus (ADA, Figure 1) will consist of a large flume fitted with a 12-inch diversion pipe inserted through the wall 4 ft from the bottom. The diversion pipe will be fitted with one of four experimental screen types (see Fish Screens). During operation, water will circulate between the ADA and a temperature-controlled sump tank (60,000 gal; pump capacity: 20 cfs) and within the ADA between a reservoir tank and the experimental flume section equipped with the pipe diversion (pump capacity: 60 cfs). Water diverted through the experimental diversion (pump capacity 5-10 cfs) will pass through a fish collection tank equipped with a lift net before draining into the sump tank. Lateral flows within the experimental flume section will be generated by the ADA recirculating pump and straightened using vanes and baffles upstream of the experimental section. Constant water depth in the flume will be maintained draining excess water into the sump tank through an internal standpipe (diameter: 48 in) located at the downstream end of the flume. Fish will be confined in an area around the diversion pipe using rigid plastic mesh partitions (confinement area dimensions: 12 ft long, 10 ft wide, 8 ft deep). Water temperature in the sump tank will be controlled by recirculation with the temperature-controlled sump tank and an accessory 25-hp thermostatted chiller plumbed directly into the ADA reservoir tank. For each experimental flow regime (see Flow Velocity) and fish screen treatment, water velocities at specific locations in the area around the diversion will be measured using a three-dimensional Doppler flow meter.

Species: While a number of small-size Delta and riverine fishes are thought to be adversely affected by agricultural diversions, priority for these experiments will be:

1) chinook salmon
2) delta smelt
3) splittail
4) steelhead trout

Fish Screens: Four agricultural diversion screening strategies will be tested.

1) No fish screen.
2) Fixed cylindrical screen with air burst cleaning system (e.g., Johnson Intake Screen, single drum).
3) Rotating cylindrical screen (e.g., Lakos Self-cleaning Industrial Pump Intake Screen).
4) Conical screen (e.g., custom manufactured by U. S. Filter/Johnson Screens)

All three screens will have approximately equivalent screen areas and will be fitted with 3/32" (2.38 mm) woven wire or profile wire mesh screen.

Flow Velocities: For all four fish screen treatments, the volume of water diverted per unit time will be roughly equal and set to achieve the current approach velocity criteria, 0.33 fps (10 cm s^{-1}), for each of the three fish screens. (Some adjustments in water diversion rates will be necessary to compensate for differences in screen area.) Approach velocity at the pipe entrance for the unscreened diversion will be higher. Two experimental and one control flow regimes will be tested.

Approach Velocity (fps)	Lateral Velocity (fps)
0.33	0
0.33	0.5
0 (control)	0

Environmental Conditions: Experiments will be conducted at two temperatures: 19°C during the summer and fall and 12°C during the winter and spring, and at two times of day (photophase): daytime (2h after sunrise to 2 h before sunset) and nighttime (2 h after sunset). All experiments will be conducted in fresh water (0 ppt salinity).

Measurements: For each experiment, two types of measurements will be made. Fish behavior and their responses to the agricultural diversion will be measured during the experimental exposure period. The physiological effects of exposure to the agricultural diversion will be measured at selected times after the end of the experimental exposure period.

Fish behavior and responses to the agricultural diversion will be monitored during each experiment visually by researchers as well as recorded by two 60 frame s^{-1} video cameras mounted in stationary locations. One camera will be suspended above the apparatus to view the diversion and fish from above, the other will be positioned to view the fish directly in front of and beside (upstream or downstream) the diversion. Nighttime video recording will use a video camera equipped with an infra-red sensitive night vision scope. Recordings from each camera will be analyzed using a computer-assisted motion analysis system (Peak Performance Technologies, Inc., Engelwood, CO). For each video record, information on distance, flow velocities and directions, and fish size will be incorporated into the computer program and/or data record for calibration purposes. Measurements will include fish orientation, location within the apparatus (e.g., distance from screen surface), swimming velocity, distance and direction traveled, loss of equilibrium, and impingement on screen. Fish orientation, and distance, direction and velocity traveled over the ground will be combined with velocity-vector maps of the ADA to calculate true swimming velocities and distance traveled through the water by individual fish.

Physiological responses will be evaluated using two standards of performance, mortality and sublethal stress. Survival will be monitored during all experiments and for a minimum of 96 h post-test in fresh water. Sublethal stress will be quantified using several blood/plasma parameters known to be associated with stress, including hematocrit, osmolality, and cortisol, lactate, and glucose concentrations. Given the small size of the test fish, blood parameters will be measured in replicated pooled samples rather than individual fish.

Experimental Protocol: Each experiment will consist of an initial pre-test, habituation period during which approach flow = 0 fps and lateral flow = 0-0.2 fps (0-6 cm s^{-1}), a test period during which the water will flow through the diversion at the prescribed rate and past the diversion at the selected lateral velocity, and a post-test period during which water flow through the diversion is suspended and lateral flow returned to the pre-test levels. Our preliminary plans call for 1 h, 0.25-2 h, and 1 h for the pre-test, test, and post-test periods, respectively, but these durations may be modified depending on results of pilot studies. For each experiment, 20-40 fish will be used (final group size for each species to be determined by pilot studies).

B. Location of Project

This stressors, habitats, and species addressed by this project are located in all areas within the Sacramento-San Joaquin Delta and river system that are affected by small unscreened and screened water diversions. Although the project will be implemented at the University of California, Davis (UCD), the results will be made available to IEP agency decision makers for implementation in the Delta and tributary rivers.

C. Expected Benefits

This project addresses problems in the Sacramento-San Joaquin Delta and tributary rivers associated with alteration of flows and effects of water management activities. The project is designed to identify, evaluate, and quantify the benefits and, possibly, the limitations of installation of fish screens at agricultural diversions, a restoration activity whose value for protecting fishes and improving ecosystem quality is not yet documented. The results will have application and provide benefit to several habitat types, including tidal perennial aquatic habitat, instream aquatic habitat, and shaded riverine habitat, and all fishes which reside in or pass through these habitats. This project will specifically evaluate the effects of small diversions and fish screens on several priority fish species, chinook salmon, delta smelt, splittail and steelhead trout, and results may be applicable to predict diversion and screen impacts on other ecologically and/or morphologically similar species not tested (e.g., longfin smelt, striped bass). Expanding our understanding of the effects of installation of fish screens beyond the issue of fish exclusion to that of fish protection is essential to the CALFED mission of ecosystem restoration and enhancing fisheries resources (including fish doubling goals mandated by the CVPIA) while maintaining water use by small diverters throughout the system. Further, understanding of the possible differential performance of different screen types on different species and under different environmental conditions (e.g., day vs night) will assist environmental managers and water diverters to apply adaptive management techniques to maximize water usage while minimizing deleterious effects on fishes in the Delta and river systems. Finally, this apparatus, once developed, will also be useful for studies on the effects of other environmental and biological conditions (e.g., turbidity, salinity, fish size, other species), screen types (including flat plate screens), diversion orientation or configuration, fish bypass structures, and pump types (e.g., "fish friendly" pumps) on fish survival and behavior.

D. Background and Biological/Technical Justification

Installation of fish screens at unscreened water diversions throughout the Sacramento-San Joaquin Delta and river system has been identified by CALFED as an activity which provides a direct benefit to fish resources and the ecosystem. However, the only benefit of fish screen installation documented to date is the exclusion of fishes >5 mm in length. It is not known whether excluded fishes are harmed or killed by exposure to artificial water flows at the diversions (i.e., entrainment) or impingement on the fish screens. The direct benefit attributed to screen installation is unproven.

The proposed project will evaluate the effectiveness of fish screens for both fish exclusion and fish protection. Our results will provide environmental managers and water users with information essential to make decisions regarding screen types and operation that, by protecting fishes, enhance ecosystem functioning and quality. This experimental approach and use of a laboratory-based system for a biological evaluation of the fish protection qualities of fish screens is preferable to field studies and will provide greater direct benefit than detailed hydraulic evaluations of various screen types for several reasons.

1) Observations of fishes near fish screens installed at water diversions in the Delta or rivers are logistically and technically difficult (e.g., turbid water conditions limit visibility for human or video observations).

2) The presence, numbers, species, and sizes of fishes near any particular diversion are not predictable and can not be replicated, therefore development of a scientifically and statistically valid study to assess screen effectiveness is difficult. Artificial introduction of test fish near the diversion and screen is problematic because the effects of exposure to the diversion can not be easily separated from the stressful effects of handling and release, and these stressed fish may respond differently to the diversion than unhandled fish.

3) Long-term effects of exposure and impingement on field-exposed fishes can not be evaluated (e.g., the effects of post-exposure collection and handling are difficult to distinguish from screen exposure and impingement effects).

4) Environmental conditions (e.g., temperature, lateral flow rates, light levels) are inherently uncontrolled and can not be replicated or tested quantitatively.

5) Swimming performance and behavior studies using flumes, flow tables, and large tanks with many fishes, including priority Delta species, have consistently shown that fishes respond to many stimuli, not just flow velocity and direction, and that their responses vary with environmental conditions (e.g., day vs night). Therefore, while detailed descriptions of flow regimes at fish screens are helpful, they can not be used to predict fish responses or movement patterns near these structures.

While the proposed project is new, it continues the applied research interest and collaborative activities of our laboratory on the effects of flows, fish screens, and environmental conditions on the performance, behavior, and physiology of Delta fishes. Much of the required laboratory, fish holding, and hydraulic facilities and infrastructure are in place and available (see G. Implementability, Available Facilities). This project capitalizes on a number of existing and new cooperative and collaborative arrangements between our applied environmental biology research group and the UCD Civil and Environmental Engineering Department Hydraulics Laboratory, state and federal resource agencies (e.g., DWR, DFG, USFWS), and several commercial enterprises (e.g., Claude Laval Corp., U. S. Filter/Johnson Screens). It also complements several ongoing and proposed projects, including the Fish Treadmill project (DWR contract # B-80898), a field-based investigation of fish exclusion at screened and unscreened agricultural diversions on Sherman Island in the Delta, and detailed hydraulic tests of several commercially available small diversion fish screens.

E. Proposed Scope of Work

The proposed project consists of two phases. Phase 1 (duration: 6 months) includes final design modifications, acquisition of materials, construction of the ADA, and preparation and approval of a Quality Assurance Project Plan. Phase 2 (duration: 2 years) will consist of pilot studies to finalize experimental parameters and protocols, development of detailed flow profiles for each of the fish screen and flow velocity treatments, and subsequent replicated experiments, data collection, analyses, and interpretation. Work during Phase 2 will be prioritized and scheduled to test the unscreened water diversion and the fixed cylindrical fish screen treatment during the first year of this phase in order to provide complementary data for the IEP Sherman Island project as quickly as possible. During the second year of Phase 2, the final two fish screen treatments will be evaluated. Progress and results will be reported in quarterly financial and progress reports and three final reports, submitted at the ends of Phase 1, and Year 1 and Year 2 of Phase 2).

F. Monitoring and Data Evaluation

Data collection, acceptability, quality control, and evaluation will be described thoroughly in a Quality Assurance Project Plan prepared by the Principal Investigator and research staff (including research collaborators from state and federal agencies) and reviewed and approved by one or more experts from these collaborating agencies who are not directly involved in the project. In addition to quarterly, annual and final reports, results will be presented at interagency workgroup meetings and workshops, professional scientific meetings, and published in peer-reviewed scientific journals in the appropriate fields.

G. Implementability

The proposed project is highly implementable. It utilizes existing facilities and resources at the University of California, Davis, ongoing and productive collaborative and cooperative arrangements with a number of state and federal resources agencies, and fosters further development of working relationships between these entities and several commercial enterprises (e.g., fish screen producers). It capitalizes on a unique combination of available, functional laboratories and expertise in fish biology (including Delta fishes), hydraulics, and fish screen technology and operation (see V. Applicant Qualifications). There are no laws, regulations, land use conditions, hazardous materials concerns, etc. which would delay or preclude implementation of this project.

Available Facilities: Most of the substantial infrastructure and capital equipment required for the project is already in place and available. The project will be implemented at the UCD Hydraulics Laboratory where the ADA will be constructed and installed, the UCD Aquatic Center where most of the experimental fishes will be maintained, and UCD Fish Environmental Physiology Laboratory where behavioral and physiological data and samples will be analyzed. Hydraulic Laboratory facilities include: a dedicated well which provides non-chlorinated, air-equilibrated water; a temperature-controlled, 60,000 sump tank; a temperature-controlled fish holding facility; pumps and associated plumbing; analytical equipment including three-dimensional Sontec Acoustic Doppler velocimeter with downward and side look probes; computers; and an experienced staff for construction, plumbing, and technical support. Aquatic Center facilities include: a dedicated well which provides non-chlorinated, air-equilibrated water; a large scale, temperature-controlled fish holding facility (e.g., 23 tanks are available for this project); and an experienced staff for fish care and technical support. The Fish Environmental Biology Laboratory facilities include: analytical equipment for blood/plasma analysis; computer-assisted motion analysis system; video and night vision equipment; and computers with necessary database access and software.

Permits: Required permits for animal collection and care, and water use and discharge are on file or currently being processed.

Cooperative arrangements: Ongoing and planned cooperative arrangements between the Fish Environmental Biology Group (Department of Wildlife, Fish, and Conservation Biology) and other University, state agency, and commercial entities are listed below.

UCD Hydraulics Laboratory (Department of Civil and Environmental Engineering): Assist in design, construction, testing, and operation of the ADA.
UCD Fish Pathology Laboratory (School of Veterinary Medicine): Fish disease diagnosis and treatment.
DWR: Assist in design, construction, testing, and use of the ADA for experiments.
DFG: Assist in fish collection and experiments
Claude Laval, Corp.: Provide rotating cylindrical drum screen.
U. S. Filter/Johnson Screen (pending): Provide fixed cylindrical and conical fish screens.
Cornell Pump Co. (pending): Provide "fish friendly" pump for ADA pipe diversion.

IV. COSTS AND SCHEDULE TO IMPLEMENT PROPOSED PROJECT

A. Budget Costs

Total funding requested from CALFED is $622,940 for 2.5 years (see Table 1). Budget costs for Phase 1 include salaries and benefits of 2 Hydraulic Laboratory mechanicians (25% time) and 3 hydraulic engineers (post-graduate researchers, 25-50% time) who will construct and test the ADA, materials and supplies to construct the ADA, travel for acquisition of construction materials and supplies and preliminary fish collection, UCD Aquatic Center fees, publication costs, and overhead. The budget costs for the construction and installation of the ADA include materials for the flume tank, reservoir tank and associated plumbing, pumps, electrical installation, and a pole-barn type structure to cover the apparatus. Construction and/or installation of this apparatus at a facility without the water handling and fish holding infrastructure available at the UCD Hydraulics Laboratory would be more expensive. Budget costs for Phase 2 are mainly for salaries and benefits for research and support staff, supplies, travel and overhead. Students will be employed on an hourly basis, but implementation of the project requires salaried personnel for operation and maintenance of the ADA (1 hydraulic engineer, 25% time), and fish collection, care, experimental set-up, data collection and analysis, and preparation of reports and journal articles (3 post-graduate research biologists, 100% time, and student assistants, hourly).

Funding Partners: Extensive cooperation and collaboration with engineers and biologists from DWR and DFG are anticipated (see Table 2 for support, including in kind, from funding partners). DWR will provide the part-time services of a hydraulic engineer for consultation and assistance during the design, construction and testing of the ADA, and a biologist to assist with the preparation of the QAPP and the design, implementation, and analyses of experiments using the ADA. DFG will provide personnel and equipment to assist in fish collection, and biologist (approx. 10% time) to assist with the preparation of the QAPP and the design, implementation, and analyses of experiments using the ADA. Claude Laval Corp. (Fresno, CA), which manufactures the Lakos Self-cleaning Industrial Intake Screen, has agreed to provide a suitably sized screen for use in the experiments with the ADA and negotiations with U. S. Filter/Johnson Screens (Castro Valley, CA) for a similar arrangement with the other two experimental screen types are ongoing. Negotiations are also ongoing with Cornell Pump Co. (Portland, OR) for use a "fish friendly" pump.

Potential for Incremental Funding: Because the proposed project requires a moderately large capital outlay for construction of the ADA before experiments can be initiated, and involves relatively long-duration and complex biological tests on live fishes which may only be available seasonally, the potential for incremental funding is limited. Biological experiments, particularly those designed to test several variables (e.g., fish species, screen types, day vs night), require replication in order to produce scientifically and statistically valid results and are time consuming. Further, a multi-year commitment will facilitate attracting and keeping top-quality post-graduate researchers and maintaining a smoothly running program.

Table 1. Cost breakdown of funding requested from the CALFED Program.

	Phase I (six months)	Phase II (Year 1)	Phase II (Year 2)
Salary and benefits	40,400	160,000	163,000
ADA construction materials and associated equipment	122,000	0	0
Miscellaneous supplies for construction , office, and experiments	25,000	20,000	20,000
Other direct costs (water fees, travel, publication, etc.)	7,000	10,000	10,000
Overhead (10% of direct cost excluding equipment)	7,240	19,000	19,300
TOTAL	201,640	209,000	212,300

GRAND TOTAL (2 ½ years) = $622,940

Table 2. Total funding for the project including counterparts from funding partners.

	Phase I	Phase II (Yr 1)	Phase II (Yr 2)	Total
UC Davis	40,000 [a, b]	9,000 [a]	9,000 [a]	58,000
DWR	78,000 [c, d]	28,000 [c]	28,000 [c]	134,000
DFG		50,000 [e]	50,000 [e]	100,000
Screen/pump co.	26,000 [f]	0	0	26,000
CALFED	201,640	209,000	212,300	622,940
TOTAL	345,640	296,000	299,300	940,940

Legends:
[a] salary for J.J. Cech (10%)
[b] 25 hp chiller and 50 ft of 48" diameter pipe
[c] estimated salaries of DWR personnel
[d] 2 units of 30 cfs pumps
[e] salaries and equipment for fish collection
[f] fish screen and pump donation

B. Schedule Milestones

Phase 1	
January 1998	Funding begins; Final design modifications, acquisition of materials, and construction and testing of the ADA; Prepare Quality Assurance Project Plan;
May/June 1998	Begin fish collection from Sacramento-San Joaquin Delta, rivers, and fish hatcheries.
August 1998	Submit final report for Phase 1
Phase 2, Year 1	
July 1998	Develop flow profiles for unscreened and fixed cylindrical screens; Conduct pilot studies to finalize experimental parameters and protocols;
August 1998- June 1999	Conduct replicated experiments with splittail (spring-summer), delta smelt (summer-spring), chinook salmon (winter-spring), steelhead (spring-summer); Fish collection as necessary.
June 1999	Submit annual report for Year 1.
Phase 2, Year 2	
July 1999	Develop flow profiles for rotating cylindrical and conical screens;
July 1999- May 2000	Conduct replicated experiments with splittail (spring-summer), delta smelt (summer-spring), chinook salmon (winter-spring), steelhead (spring-summer); Fish collection as necessary.
June 2000	Submit annual report for Year 2 and final report for Phase 2.

C. Third Party Impacts

Application of the results of this proposed project could have impacts on sport, commercial and native Californian fisheries by improving protection of fishes at small water diversions throughout the Delta and river system and thus enhancing fish populations. Results could also have impacts on small water diverters by suggesting improved designs and operational guidelines for diversions and fish screens which better protect Delta and riverine fishes.

V. APPLICANT QUALIFICATIONS

A. Organization of Staff

The project will be under the direction and supervision of the principal investigator, Dr. J. J. Cech, Jr., Professor in the Department of Wildlife, Fish, and Conservation Biology, University of California, Davis. Construction, testing, and operation of ADA and associated Hydraulic Laboratory facilities will be under the direction and supervision of Dr. M. L. Kavvas, Professor in the Department of Civil and Environmental Engineering, University of California, Davis. Day to day project management, implementation, data analysis, interpretation, and report writing will be provided by two post-graduate researchers, Drs. C. Swanson and P. S. Young. One full-time and one or three (depending on Phase) full and part-time post-graduate researchers will assist with ADA construction, operation, fish collection and care, and data collection and analysis. Collaborating engineers and biologists from DWR and DFG will work with the principal investigator and managing biologists.

B. Collaborating Scientists

Dr. Joseph J. Cech, Jr. has been a professor at UCD since 1975 and was Chair of the Department of Wildlife, Fish, and Conservation Biology from 1992-1997. He has published more than 80 peer-reviewed articles and books in the fields of physiology and physiological ecology of fishes, and has won numerous awards, honors, and grants. He has successfully completed seven contracts with state agencies for studies of the physiological ecology of fishes in the Sacramento-San Joaquin Delta and rivers. He is currently co-principal investigator, with M. L. Kavvas, on the Fish Treadmill Project (DWR contract # B-80898), a comprehensive study of the performance and behavior of Delta fishes exposed to three-dimensional flow fields and large flat-plate fish screens. Recent relevant publications include:

Cech, J. J., Jr., Mitchell, S. J. Castleberry, D. T., and McEnroe, M. (1990) Distribution of California stream fishes: influence of environmental temperature and hypoxia. Env. Biol. Fish. 29:95-105.

Moyle, P. B. and Cech, J. J., Jr. (1996) Fishes: an introduction to ichthyology. 3rd edition, Prentice Hall, Englewood Cliffs, New Jersey.

Cech, J. J., Jr., Bartholow, S. D., Young, P. S., and Hopkins, T. E. (1996) Striped bass exercise and handling stress in freshwater: physiological responses to recovery environment. Trans. Am. Fish. Soc. 125:308-320.

See also other co-authored publications listed below.

Dr. Christina Swanson has been a post-doctoral researcher in Dr. Cech's laboratory has spent the past four years studying the environmental tolerances, swimming performance, and behavior a Delta fishes, with an emphasis on the biology of delta smelt. She was the managing researcher on three successfully completed state contracts and is currently one of the managing biologists on the Fish Treadmill Project. Recent relevant publications include:

Swanson, C. and Cech, J. J., Jr. (1995) Environmental tolerances and requirements of delta smelt, *Hypomesus transpacificus*. Final Report for California Department of Water Resources, Contracts B-59449 and B-58959. 77 pp.

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Swanson, C. Mager, R. C., Doroshov, S. I., and Cech, J. J., Jr. (1996) Use of salts, anesthetics, and polymers to minimize handling and transport mortality in delta smelt. Trans. Am. Fish. Soc. 125:326-329.

Swanson, C., Young, P. S., and Cech, J. J., Jr. (1996) Swimming studies on an estuarine fish: are performance indices the best tool to develop flow management criteria?. Proceedings of the Applied Environmental Physiology of Fishes Symposium, International Congress on the Biology of Fishes, San Francisco State University, July 14-18, 1996. Pp. 83-91.

Swanson, C., Young, P. S., and Cech, J. J., Jr. (1997) Swimming performance and behavior of delta smelt: maximum velocities, endurance, and kinematics in a laminar-flow swimming flume. Final Report for California Department of Water Resources Contract # B-59742. 67 pp.

Dr. Paciencia S. Young received her doctoral training and is currently a post-doctoral researcher in Dr. Cech's laboratory. She is an expert in the areas of stress and exercise physiology of fishes and has spent the past three years studying the environmental tolerances, swimming performance, and behavior a Delta fishes, with an emphasis on the biology of splittail and delta smelt. She was the managing researcher on two successfully completed state contracts and is currently one of the managing biologists on the Fish Treadmill Project. Recent relevant publications include:

Young, P. S. and Cech, J. J., Jr. (1993) Effects of exercise conditioning on stress responses and recovery in cultured and wild young-of-the-year striped bass (*Morone saxatilis*). Can. J. Fish. Aquat. Sci. 50:2094-2099.

Young, P. S. and Cech, J. J., Jr. (1995) Environmental requirements and tolerances of Sacramento splittail, *Pogonichthys macrolepidotus* (Ayres). Final Report to the Interagency Ecological Studies Program for the San Francisco Bay/Delta. 56 pp.

Young, P. S. and Cech, J. J., Jr (1996) Environmental tolerances and requirements of splittail. Trans. Am. Fish. Soc. 125:664-678.

Dr. M. Levent Kavvas has been a professor in the Department of Civil and Environmental Engineering since 1985 and Director of the UCD Hydraulics Laboratory since 1994. He is the author of more than 75 journal and proceedings publications in the areas of hydraulic and hydrologic engineering. His areas of specialization include: physical hydraulic modeling of environmental fluid flows; pollutant and sediment transport; and modeling of hydrologic processes such as overland flow, ersosion, and infiltration. He has been a member of the editorial boards of several engineering journals and is currently an editor of ASCE Journal of Hydrologic Engineering. Dr. Kavvas is principal investigator on the Fish Treadmill project, a large collaborative project between the Hydraulics Laboratory research group, our applied environmental biology research group, and DWR and DFG. Recent relevant publications include:

Velagic, E., Kavvas, M. L., Summer, W. and others (1996) Fish screen test apparatus with variable two-vector flow conditions: hydraulic model. Final Report for California Department of Water Resources Contract # B-58719. 32 pp.

Engr. Shawn Mayr (participation pending), a civil engineer with the Fish Facilities Section, Environmental Services Office, DWR currently working with our research group and Hydraulics Laboratory on the Fish Treadmill project, will assist and consult with the Hydraulics Laboratory on design, construction, testing and operation of the ADA.

Mr. Ted Frink, a biologist with the Fish Facilities Section, Environmental Services Office, DWR, currently working with our research group and Hydraulics Laboratory on the Fish Treadmill project, will assist and consult with us on the QAPP, experimental design, implementation, and data analysis for the ADA experiments.

Mr. Robert Fujimura (participation pending), is a biologist with DFG currently working with our research group on the Fish Treadmill project. He will assist and consult with us on the QAPP, experimental design, implementation, and data analysis for the ADA experiments.

C. Conflicts of Interest

There are no existing or potential conflicts of interest for any of the personnel involved in this project.

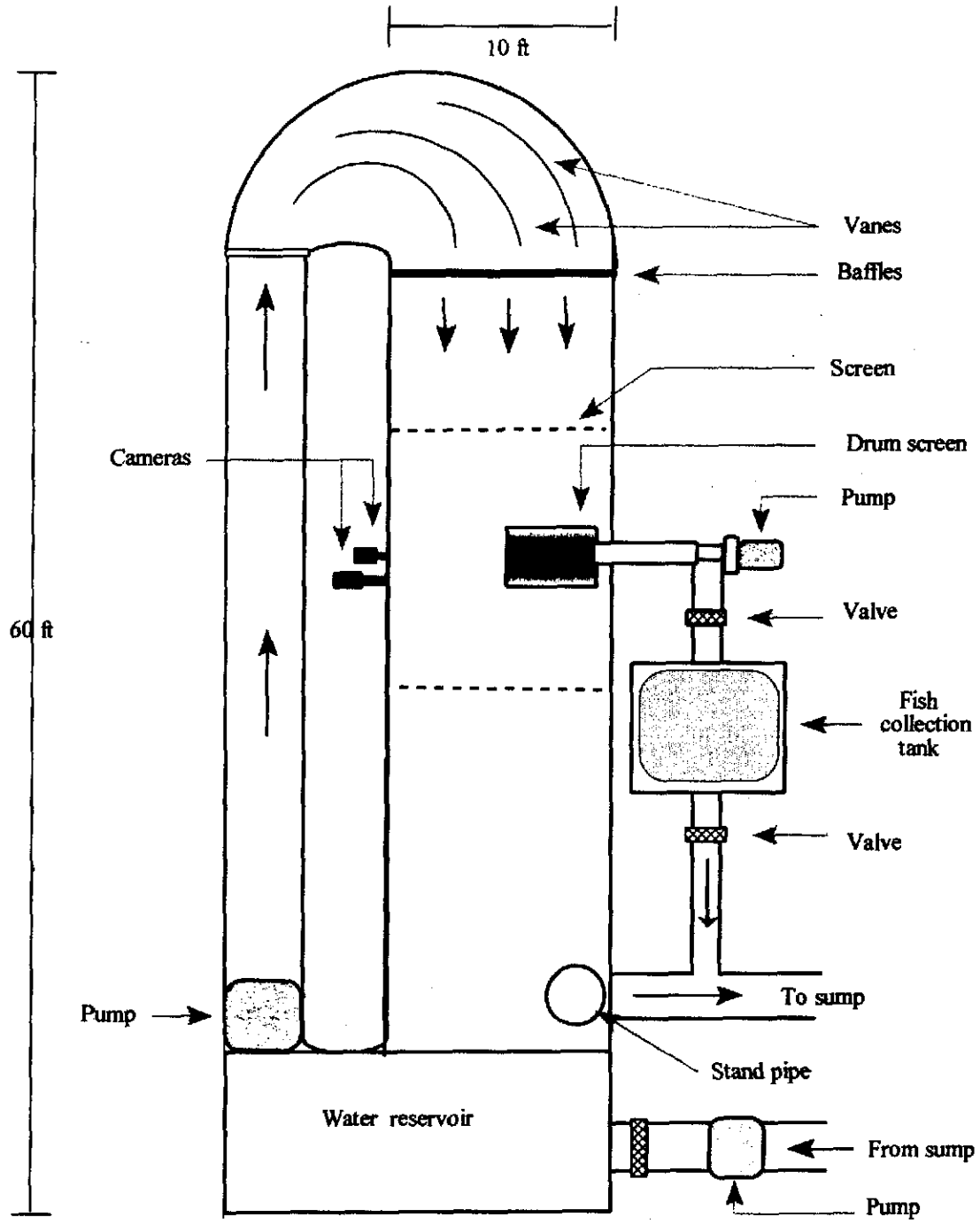

Figure 1. Diagram of the proposed design for agricultural diversion apparatus.

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Item 8

NONDISCRIMINATION COMPLIANCE STATEMENT

COMPANY NAME: THE REGENTS OF THE UNIVERSITY OF CALIFORNIA

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, disability (including HIV and AIDS), medical condition (cancer), age, marital status, denial of family and medical care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

OFFICIAL'S NAME: Sandra M. Dowdy
Contracts and Grants Analyst

DATE EXECUTED: JUL 28 1997

EXECUTED IN THE COUNTY OF: YOLO

PROSPECTIVE CONTRACTOR'S SIGNATURE: Sandra M. Dowdy

PROSPECTIVE CONTRACTOR'S TITLE:

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME: THE REGENTS OF THE UNIVERSITY OF CALIFORNIA

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